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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

August 27 - September 2, 1999

Summary 99-35

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EVENTS

1. EMPLOYEES POTENTIALLY EXPOSED TO MERCURY VAPOR

On August 25, 1999, at the Savannah River Tritium Facility, industrial hygienists determined that several employees may have been exposed to elevated levels of mercury vapor while draining and cleaning a mercury vapor pump used as a training aid at a maintenance training facility. The facility had initially procured the pump as a spare pump for use in tritium or deuterium gas processes. To prepare it for installation, mechanics were removing mercury residue that was incompletely drained from the pump after manufacturer's tests. This occurrence is significant because exposure to high levels of mercury can cause serious health problems. (ORPS Report SR--WSRC-TRIT-1999-0018)

Industrial hygienists analyzed breathing zone air samples that ranged from 0.016 to 0.028 milligrams of mercury per cubic meter of air. Floor area samples near the pump, and in a carpeted office adjacent to where the pump was stored, ranged from 0.016 to 0.029 milligrams per cubic meter. The highest level detected was 0.16 milligrams per cubic meter at the sole of an industrial hygienist's shoe. Industrial hygienists also measured 0.016 milligrams per cubic meter of mercury at the sole of a shoe belonging to an office worker whose office was in the room adjacent to the pump. The American Conference of Governmental Industrial Hygienists threshold limit value for mercury vapor is 0.025 milligrams per cubic meter as a time-weighted average for an 8-hour work day or a 40-hour work week.

Facility personnel immediately evacuated and barricaded the room containing the pump to prevent further exposure, and industrial hygienists obtained blood samples from a supervisor, a mechanic, and an office worker. The facility manager initiated a preliminary investigation and held a critique. Critique participants and investigators determined the following.

- The pump manufacturer tests each new pump by pumping mercury vapor through it, then draining the mercury from the casing. However, residual mercury may remain in low points and obstructions within the pump.

- Several years ago, facility personnel removed the pump from storage and placed it in the training facility for training on the disassembly and repair of similar pumps. Their objective was to reduce radiological exposures associated with repairs in the field. No one has reported the presence of mercury during the time that the pump has been used for training.

- Approximately 6 months ago, mechanics noticed mercury droplets on the pump while checking to see if they could use it to replace a failed pump. Maintenance personnel prepared a work plan to drain and clean the mercury residue from the pump. The work plan specified that industrial hygienists would provide continuous monitoring for mercury.

- On August 25, mechanics removed the drain cap from the base of the pump to determine the size of the drain fitting required. They elevated the pump several inches to allow room for a drainage container. None of them observed signs of mercury during these initial preparations. The mechanics then requested industrial hygienists to conduct a series of baseline mercury vapor measurements before beginning the work of draining and cleaning the pump. Industrial health technicians discovered the elevated mercury levels at that time.

Prompt follow-up actions for this occurrence included (1) capping and packaging the pump and relocating it to a controlled area, (2) removing carpet from the affected office area and reducing mercury vapor levels to as low as reasonably achievable, and (3) conducting a follow-up critique to identify additional causes and corrective actions.

Investigators tentatively identified a management problem as both the direct and root causes of this occurrence. Facility supervisors permitted personnel to relocate a device containing mercury to an uncontrolled area with little or no consideration for the associated hazards. Additionally, facility personnel did not routinely monitor the area to ensure that the mercury was not exposed to the atmosphere. Consequently, no data exists regarding exposures that may have occurred when the pump was handled during training sessions. Finally, facility personnel received less than adequate training in the hazards of mercury. If workers had been more aware of the potential health effects of exposure to mercury, they would have given a much higher priority to hazard analysis and work planning after mercury droplets were discovered.

This occurrence underscores the importance of thorough hazard analysis and work planning for tasks involving potential mercury exposures. Exposure to mercury vapor can occur through inhalation or through skin or eye contact. Mercury vaporizes readily at room temperature, and the rate of vaporization increases dramatically as temperature increases. Mercury vapor can affect the central and peripheral nervous systems, lungs, kidneys, skin, and eyes in humans. Mercury vapor is also mutagenic and can affect the immune system. Acute exposure to high concentrations of mercury vapor can cause severe respiratory damage; chronic exposure to lower levels is primarily associated with central nervous system damage. Although a threshold limit value exists for exposure to mercury vapor, industrial hygienists and work planners should use protective measures to ensure that exposures to mercury vapor are as low as reasonably achievable. These measures may include containment or enclosure, respiratory protection, ventilation, limited work shifts, or skin and eye protection.

Many occurrences in the ORPS database that involved potential exposures to mercury vapor occurred through spills, breakage, inadvertent process releases, or other accidental causes. Facility managers should ensure that employees are trained on the potential sources of mercury and mercury vapor, the hazards of exposure to mercury vapor, and the emergency response to mercury spills or releases. Employees should be instructed to evacuate the general area of a spill, to report the spill immediately, and not to attempt to clean it up themselves.

OSHA Standard 29 CFR 1910.1000, *Air Contaminants*, provides permissible exposure limits, ceiling limits, and protective measures for a wide range of airborne hazardous substances. The standard requires employers to determine and implement administrative or engineering controls to achieve compliance with exposure limits. When such controls are not feasible to achieve full compliance, employers must keep the exposure of employees to air contaminants within prescribed limits using protective equipment or other protective measures. Any equipment or technical measures used for this purpose must be approved for particular applications by competent industrial hygienists or other technically qualified persons. Table Z-2 of the standard lists the permissible exposure limit for mercury as 0.050 milligrams per cubic meter as a time-weighted average for an 8-hour work shift or a 40-hour work week. However, DOE has adopted the more conservative limit published by the American Conference of Governmental Industrial Hygienists.

OSHA's *Occupational Safety and Health Guideline for Mercury Vapor* summarizes information about mercury vapor for workers, employers, and occupational safety and health professionals. Contents include exposure limits, health hazards, exposure sources and control methods, medical surveillance, monitoring and measurement, special requirements, respiratory protection, and personal protective equipment. The guideline also contains references to several related standards and publications.

OSHA standards, health guidelines, and other publications related to exposures to hazardous substances are available from the OSHA home page at URL http://www.osha.gov.

KEYWORDS: exposure, hazard analysis, industrial hygiene, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

2. VIOLATIONS OF RADIOACTIVE MATERIAL INVENTORY DOCUMENTATION

On August 25, 1999, at the Oak Ridge Y-12 Site, development division personnel discovered two americium-lithium sources (with activity levels of 10 curies and one curie) in a building categorized as non-nuclear. Facility personnel considered both sources exempt from the threshold values specified in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,* and the sources were not referenced in the facility authorization basis document. However, their activities exceeded the value over which a safety and hazard analysis must be performed to categorize the facility. Errors in radionuclide inventories could result in personnel exposures to hazardous levels of radioactivity in the event of a radioactive release. (ORPS Report ORO--LMES-Y12SITE-1999-0042)

The building is controlled as a facility below Category 3 as defined by DOE-STD-1027-92. The standard specifies that sealed radioactive sources must either demonstrate compliance with ANSI N43.6, *Sealed Radioactive Sources, Categorization* or 49 CFR 173.469, which specifies testing methods for radioactive materials, or must be contained in DOT Type B shipping containers to exclude them from the radioactive inventory. Facility personnel are procuring a Type B container to store the sources.

Facility managers at two other Y-12 Site buildings, also categorized as non-nuclear, have recently reported discrepancies in their radioactive source inventory documentation. On August 5, the radiological controls manager identified sealed neutron sources stored in a building containing a storage area for surplus and legacy sources that did not have sufficient documentation to demonstrate compliance with the requirements of DOE-STD-1027-92. Without an exemption for these sources, threshold quantities for a Category 3 nuclear facility were exceeded. (ORPS Report ORO--LMES-Y12SITE-1999-0039) On August 6, while performing an inventory of radioactive sources, operations personnel discovered that the quantity of radioactive material in another building exceeded the threshold limits for a Category 3 nuclear facility. (ORPS Report ORO--LMES-Y12SITE-1999-0041) One of these facilities does not have a safety authorization basis document. The other has a safety analysis report. Facility personnel had stored the sources in these two buildings in approved containers. Facility managers are preparing an Unreviewed Safety Question Determination for all three buildings.

DOE-STD-1027-92 provides guidance for determining the hazard category of a facility. Attachment 1 of the standard provides threshold values for various radionuclides. If the quantity of material (in curies or grams) exceeds the threshold value, the facility should be categorized at the next highest level. A facility initially assigned as a hazard category 1, 2, or 3 requires a final safety evaluation in accordance with DOE O 5480.23. *Nuclear Safety Analysis Reports.* The final safety evaluation may then change the hazard categorization of the facility from the initial categorization based on radionuclide quantity.

These events underscore the importance of facility hazard characterization and nuclear inventory controls, including the requirement to have the proper documentation and certification of sealed radioactive sources. Managers responsible for the storage and handling of nuclear materials should inventory actual amounts of nuclear material at storage locations and compare the results with existing tracking systems. They should ensure that a system exists to correctly track nuclear material inventory changes and should have a program for periodically inspecting nuclear material to ensure that the inventory and configuration have not changed. All changes to requirements and inventories should be rigorously and systematically captured in revisions to facility basis documents and procedures. Additionally, workers should be properly trained on nuclear material inventory requirements.

All sources, whether accountable or exempt, are radioactive materials and must be controlled in accordance with DOE radiological protection control requirements. Facility personnel and supervisors who control, handle, store, or use radioactive materials or sealed radioactive sources should review the following documents, which contain key elements of effective radioactive material and source control programs.

- DOE-STD-1098-99, *Radiological Control*, chapter 4, “Radioactive Materials,” provides clear direction on the marking, monitoring, and control of radioactive materials. Part 414, “Radioactive Material Storage,” states that a custodian should be assigned responsibility for each radioactive material area and should conduct walk-throughs of the area to check container integrity. They should also conduct annual or more frequent reviews of each area, with emphasis on decontamination, movement of material to long-term storage locations, and disposal of unneeded material. Part 431, “Sealed Radioactive Source Control,” requires control and accountability for sealed radioactive sources. A custodian should be appointed to coordinate sealed radioactive source procurement, issue, inventory, leak testing, and other aspects of the sealed source program. Both accountable and non-accountable sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources.

- DOE G 441.1-13, *Sealed Radioactive Source Accountability and Control Guide*, provides guidance to establish a sealed radioactive source accountability and control program that complies with the requirements of 10 CFR 835. The guide addresses the key elements of radioactive source receipt, labeling and storage, inventory, leak testing, and handling and disposal.

- DOE N 441.1, *Radiological Protection for DOE Activities*, requires control of and accountability for sealed radioactive sources. The Notice establishes radiological protection program requirements that, combined with 10 CFR 835 and its associated implementation guidance, form the basis for a comprehensive radiological protection program. There are 16 top-level, performance-based requirements in this Notice. These requirements supplement and enhance the requirements of 10 CFR 835 to provide critical direction in the areas of administrative controls, radiation safety training, work authorizations, posting, exposure of minors, and sealed radioactive source accountability. DOE N 441.4, *Extension of DOE N 441.1, Radiological Protection for DOE Activities,* extends DOE N 441.1 until June 30, 2000.

Links to DOE radiation protection documents can be found at http://tis.eh.doe.gov/rhmwp/regs.html. The NRC maintains a sealed source database at http://www.nrc.gov/NRC/FEDWORLD/NRC-SSD/index.html. This database provides a list of sealed sources licensed by the NRC and a variety of information on sealed sources.

KEYWORDS: accountability, inventory, nuclear material, radioactive source, sealed source, source control, source custodian

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Radiation Protection

3. FAILURE TO REFUEL AIR COMPRESSOR CAUSES LOSS OF PLANT AIR

On August 24, 1999, at the Idaho Nuclear Technology and Engineering Center, equipment operators failed to refuel a diesel-powered portable air compressor, causing it to shut down and resulting in a loss of plant air. Air pressure dropped below the limits for sustained facility operations. The facility manager ordered an evacuation of the New Waste Calcining Facility because the air compressor shutdown reduced the plant air supply and caused the ventilation system intake dampers to close. Equipment operators were scheduled to fill the diesel fuel supply tank on the portable air compressor every 6 hours. However, scheduling problems prevented them from delivering fuel at the required time. Failure to maintain the minimum air supply resulted in a facility evacuation and could have resulted in additional facility evacuations or the spread of contamination. (ORPS Report ID--LITC-LANDLORD-1999-0011)

Operation of the New Waste Calcining Facility requires plant air to maintain process systems and instrument air for facility operation. Investigators determined that the portable air compressor was being used as a backup supply because three of the four permanently installed air compressors were out of service. They also determined that earlier in the year one of the plant air compressors failed, so maintenance personnel took it out of service for repair and scheduled it for replacement. Because of the system configuration, they also removed the permanently installed backup compressor from service until the replacement could be completed. Investigators also determined that maintenance personnel installed the portable air compressor as the backup supply for the two remaining air compressors. On August 23, one of the remaining air compressors failed, and maintenance personnel removed it from service. Because the remaining air compressor did not have the capacity to maintain the necessary plant air supply, facility personnel started the portable compressor. Investigators determined that when the portable compressor ran out of fuel, the remaining compressor could not maintain the plant air load.

The facility manager held a critique of this event. Critique members learned that equipment operators working for the Idaho National Environmental Engineering Laboratory normally refuel the portable air compressor every 6 hours. They also learned that no one from the Central Facilities Area told utilities personnel that the operators would be unavailable for one of the deliveries. The facility manager directed facility personnel to complete the following actions.

- Change the fuel delivery schedule for the portable air compressor to once every 4 hours.

- Check the portable air compressor fuel level with a dipstick every 2 hours and notify the shift supervisor if the fuel level is less than 10 inches.

- Return the permanently installed backup air compressor to service and ensure that the permanently installed air compressor that originally failed can be isolated without isolating the backup air compressor.

This event underscores the importance of an integrated approach to safety that stresses clear goals and policies, individual and management accountability and ownership, implementation of requirements and procedures, and thorough and systematic management oversight. In this event, no one communicated that the equipment operators were unavailable to deliver fuel. This violated DOE’s Integrated Safety Management System requirements to (1) perform work within controls, and (2) provide feedback on the adequacy of controls and on continuous improvement in defining and planning work. The responsibility for ensuring adequate planning and control of work activities resides with line management. Personnel at DOE facilities are required to follow established work control programs without exception.

Facility managers should ensure that maintenance activities are adequately controlled and that personnel understand the potential impact of these activities on safety systems. Reliance on portable equipment can result in unnecessary challenges to facility and personnel safety. When portable equipment is used to support facility or system operations, facility personnel should ensure that it is maintained as permanently installed equipment and that failures do not cause an accident of a new or different type, increase the consequences of an existing accident analysis, or reduce safety margins.

Facility managers should review the following documents and ensure the applicable work control elements are incorporated in current work control programs.

- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order states that work control procedures help personnel understand the necessary requirements and controls.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that managers of DOE facilities shall establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing. Chapter VIII, "Control of Equipment and System Status," states that the operating shift should know the status of equipment and systems and discusses communications necessary to maintain proper configuration control.

- DOE G 450.4-1, *Integrated Safety Management Guide*, provides extensive guidance to DOE contractors for developing, describing, and implementing an integrated safety management system to comply with DOE policy and acquisition rules. The guide addresses core functions and guiding principles related to defining scope of work, analyzing hazards, developing and implementing controls, and performing work at the facility, project, or activity level.

- DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling and Coordination of Maintenance at DOE Nuclear Facilities,* section 3.1.1.3, provides the key elements of an effective planning program. The standard recommends that experienced individuals conduct thorough reviews of work plans to eliminate any errors or confusion.

Integrated Safety Management System information can be found at http://tis-nt.eh.doe.gov/ism. DOE technical standards can be found at http://www.doe.gov/html/techstds/standard/standard.html.

KEYWORDS: job planning, maintenance, diesel fuel

FUNCTIONAL AREAS: Radiological Protection, Work Control, Management, Emergency Planning

4. OPERATOR EXCEEDS STAY TIME AND EXPERIENCES HEAT STRESS

On August 26, 1999, at the Idaho Nuclear Technology and Engineering Center, an operator exceeded the stay time for working in a high-temperature work area and experienced heat stress. The operator, wearing three sets of personal protection equipment (PPE), worked approximately 1 hour in an area where the maximum safe stay-time was 15 minutes. The temperature was approximately 100 degrees Fahrenheit, and the operator wore an acid suit, two sets of anti-contamination clothing, and a full-face respirator. A radiation control technician helped remove the operator's PPE and took him to the site medical facility. Medical personnel measured the operator's body temperature at 102 degrees Fahrenheit. Investigators determined that the operator exceeded the allowed work area stay time and that his PPE may have been excessive for the work environment. In severe cases, heat stress can result in permanent brain damage or death. (ORPS Report ID--LITC-FUELRCSTR-1999-0016)

Investigators determined that the operator initially exhibited signs of fatigue just after decontaminating a crane. His foreman and an attending radiation control technician advised the operator to sit and rest before descending from the scaffolding. After resting for approximately 5 minutes, the operator tried to descend from the scaffolding using an 18-foot ladder. The operator was approximately one-third of the way down the ladder when he swayed, recovered, and then clung to the ladder. He then slowly descended, unassisted, to the floor. Investigators determined that the job foreman calculated the maximum stay-time as 30 minutes and discussed heat stress at the pre-job briefing. A DOE—Idaho industrial hygiene subject matter expert later determined that the foreman made an error and that the stay-time should have been 15 minutes. Investigators determined that the foreman did not assign anyone the responsibility for monitoring time. This led to the operator exceeding the correct stay-time by approximately 45 minutes. The operator has no memory of events from the time he began to descend the ladder until he arrived at his home. The facility manager developed a new safe work permit and required special authorization for the use of PPE other than cloth anti-contamination clothing and respirators.

Radiological control technicians recently increased PPE requirements for this work area because of an event several days earlier. In that event, a maintenance worker's skin became contaminated after working in the Irradiated Fuel Storage Facility while wearing two sets of anti-contamination clothing. Radiological control technicians determined that contamination passed through the clothes when they became wet from perspiration. The radiological control technicians changed the PPE requirements to add an acid suit to prevent the transport of perspiration-borne contamination through the two sets of anti-contamination clothing.

NFS recently reported a similar heat stress event in Weekly Summary 99-32. In that event, an operator at the Savannah River Site experienced symptoms of heat stress after working for approximately 1 hour in a high-temperature area. The operator complained of feeling lightheaded and had stopped perspiring. They determined that the temperature in the work area was 94 degrees Fahrenheit and that the operator was wearing two sets of protective clothing and a full-face respirator. (ORPS Report SR--WSRC-FCAN-1999-0020)

These events illustrate the need for workers and job planners to consider all hazards when determining worker protection requirements for a job performed in a high-temperature area. Workers can be exposed to increased contamination hazards while wearing minimum protective clothing to reduce potential heat stress. Heat stress stay-times protect workers from the physical effects of exposure to extreme temperatures. Stay-times are maximum limits that require an individual to leave a high-temperature environment, even though the individual may feel capable of continuing work. The physical effects of heat stress often give little warning to the individual; therefore, limits must be adhered to so that worker protection is ensured.

Heat stress occurs when the body has difficulty removing all of the heat generated internally to perform work. Workers are at risk for heat stress if they (1) wear clothing or PPE that restricts sweat evaporation, (2) experience especially high work demands, or (3) are not acclimatized. Workers should not be encumbered with PPE that could place them at risk for serious injury from hazards other than radiological. The choice of PPE can affect a worker's (1) stay-time in radiation areas, (2) ease of emergency egress, or (3) ability to safely perform assigned tasks.

Radiological control managers and facility managers should assess the level of PPE and clothing necessary for radiological work activities that include other hazards that could affect worker safety. Assessment of personnel contamination risk should also apply to activities that may involve heat stress and facility emergencies. Personnel injury and life-threatening situations always have priority over radiological considerations.

DOE/EH-0256T, rev 1, *Radiological Control Manual*, Appendix 2A, provides guidelines and exposure limits for emergency exposures for life-saving activities. The manual also provides guidance for PPE and clothing.

- Article 325, "Personal Protective Equipment and Clothing," cautions that the use of PPE or clothing (including respiratory protection) beyond that authorized by the radiological control organization detracts from work performance and is contrary to as low as reasonably achievable principles and waste minimization practices. Such use should not be authorized.

- Article 534, "Heat Stress," states that heat stress may result from working in areas of high heat, humidity, and radiant heat; working in protective clothing; and using respirators, particularly where other protective equipment is required. Heat stress has occurred at ambient temperatures less than 70 degrees Fahrenheit when multiple sets of anti-contamination clothing or plastic suits were in use or strenuous work was required.

- Appendix 3C, “Contamination Control Practices,” states that protective clothing, as prescribed in the radiological work permit, should be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, and regard for non-radiological hazards that may be present.

DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, states that the contractor must identify workplace hazards and evaluate the risk of associated worker injury or illness. When a hazard is identified, managers must assess the process and take appropriate steps to prevent, abate, or mitigate the hazard.

Additional heat stress information can be obtained by searching for heat stress on the OSHA website at http://www.osha-slc.gov/. Available information includes (1) OSHA Technical Manual, *Heat Stress*; (2) OSHA “Heat Stress Card”; and (3) OSHA Fact Sheet, *Protecting Worker in Hot Environments*. A 15-page booklet, *Working in Hot Environments,* is available free from National Institute for Occupational Safety and Health Publications, 4676 Columbia Parkway, Cincinnati, Ohio 45226; telephone (513) 533-8287 or at http://www.cdc.gov/niosh/hotenvt.html.

KEYWORDS: contamination, personal protective equipment, radiation protection

FUNCTIONAL AREAS: Radiation Protection, Industrial Safety

5. OBSTRUCTED SPRINKLER HEADS VIOLATE NFPA CODES

On August 24, 1999, at the Pantex Plant, fire protection engineers identified sprinkler heads that did not comply with the obstruction distance requirements of National Fire Protection Association (NFPA) standard NFPA 13. The fire protection engineers were performing a risk management assessment in a building when they discovered that fluorescent light fixtures obstructed the spray patterns of several sprinkler heads in bays one through six. Based on this information and the guidance of the fire protection engineers, the facility manager restricted access to the bays pending a full investigation of the NFPA 13 requirements. He also declared the fire suppression system impaired, placed the bays in a repair mode, and directed operators to remove materials from the bays. The obstruction of the fire suppression system sprinkler heads can reduce their effectiveness in combating a fire, resulting in excessive damage to the facility or endangering the lives of its occupants. (ORPS Report ALO-AO-MHSM-PANTEX-1999-0061)

Fire protection engineers performed an engineering evaluation and determined that the present location of the lighting systems obstructed the spray pattern for several sprinkler heads. Some of the fluorescent light fixtures were mounted directly below the sprinkler head and less than 9 inches away. Craft personnel lowered the affected lighting fixtures to allow for a clear space of 18 inches below the deflectors of the sprinkler heads.

Investigators determined that the affected bays were in a maintenance mode at time of discovery; therefore, no operations were being conducted. They also determined that the fire suppression system in these bays has been installed since 1969.

The NFPA *Fire Protection Handbook*, section 6, “Care and Maintenance of Water-based Extinguishing Systems,” contains information on maintaining sprinkler system piping and discusses obstruction identification. The handbook identifies the following eight categories that should be considered when inspecting sprinkler systems.

- **Absence of sprinklers** — observe whether there is any room or building from which sprinklers have been omitted.

- **Improper location of sprinklers** — observe whether there are sprinklers under air ducts, shelves, benches, tables, overhead storage racks, platforms, or similar obstructions.

- **Impact of adding pipe to the system with hydraulic calculations** — check the calculations to ensure that current water pressure will suffice.

- **Proper sprinkler clearance** — ensure that sprinklers are not obstructed by piled-high stock, walls, or partitions (there must be a clear space of 18 inches below the sprinkler deflectors) and that installation guidelines have not been violated (refer to NFPA 13).

- **Proper position of deflectors** — determine that the distance of the deflectors from the ceiling or bottom of beams or joists conforms to NFPA 13.

- **Proper pitch of dry-pipe systems** — observe whether all pipes have the proper pitch to prevent collection and freezing of water in low points.

- **Proper support of piping** — observe whether any hangers are loose, any pipes are not properly supported, and pipes are not being used to support material or other items.

- **Proper sprinkler installation** — observe whether the sprinklers are installed in the positions for which they were intended. Note the type, design, year of manufacture, and date installed; check for proper temperature rating; check for corrosion and blockage; and check for coatings of paint.

Facility managers responsible for fire safety should ensure that systems are installed, inspected, and maintained using NFPA standards. NFPA 13*, Installation of Sprinkler Systems*, is the fundamental document that governs the design and installation criteria for installing sprinkler systems. NFPA 25, *Inspection, Testing, and Maintenance of Water-based Fire Protection Systems*, is another reference that facility managers should consult when performing acceptance testing, periodic testing, and maintenance.

Ordering information for NFPA documents can be found at the NFPA Home Page located at URL http://www.nfpa.org. DOE implementation of NFPA 25 can be found at the DOE Fire Protection Home Page at URL http://nattie.eh.doe.gov:80/fire/directives.html.

KEYWORDS: fire suppression, inspection, sprinkler, surveillance

FUNCTIONAL AREAS: Fire Protection

6. NEAR MISS — CONTRACTOR CUTS CONDUIT CONTAINING ENERGIZED CABLE

On August 23, 1999, at the Pantex Plant, a construction manager learned that a contractor had cut into a conduit containing a 480-volt electrical cable with a band saw. The contractor was supposed to remove a conduit for a public address system that contained low-voltage wiring but accidentally started to cut into the wrong conduit. A supervisor saw the contractor cutting the conduit, realized the mistake, and stopped him before the saw contacted the energized cable. The 480-volt cable provides power to an air handling unit in a building bay. The air handling unit was not operating at the time of the incident. The contractor was fortunate that he was stopped in time to prevent an electrical shock or injury. (ORPS Report ALO-AO-MHSM-PANTEX-1999-0060)

Electrical personnel locked out and inspected the 480-volt cable. They repaired the damaged conduit and returned the cable to service. Investigators determined that the conduit to be removed had not been marked to eliminate confusion with other conduit in the area and prevent accidental removal of the wrong one.

NFS has reported other events in the Weekly Summary concerning personnel cutting conduit that contained energized cables and wires. Some examples follow.

- Weekly Summary 99-05 reported that a construction subcontractor at the Kansas City Plant used a reciprocating saw to cut into a conduit that contained an energized three-phase, 480-volt cable. When the blade penetrated the metal conduit and the cable, an electrical arc occurred. Investigators determined that a supervisor had directed the subcontractor to cut the wrong conduit. (ORPS Report ALO-KC-AS-KCP-1999-0003)

- Weekly Summary 98-29 reported that three subcontractor electricians at the Strategic Petroleum Reserves Bayou Choctaw Site were holding energized 480-V cables while cutting the conduit that contained the cables with a band saw. Although the electricians were trained and qualified, they cut the conduit in violation of their work permit and site safety procedures that require equipment to be locked out and tagged out. (ORPS Report HQ--SPR-BC-1998-0003)

- Weekly Summary 97-14 reported that decontamination and decommissioning workers at the Hanford N-Reactor cut through a conduit into an energized 220-volt cable. Markings on the conduit indicated that the cable was de-energized and that a zero-energy check had been completed. When the workers cut the conduit and wire they observed arcing and sparking. Investigators determined that the workers bypassed a procedural hold-point and that an electrician had not conducted a zero-energy check. (ORPS Report RL--BHI-NREACTOR-1997-0006)

These events underscore the hazards involved when energized cables are accidentally cut. Managers and supervisors overseeing the removal of conduit and electrical cables should stress electrical safety techniques to their workers. Such techniques include verifying that wires are de-energized by making an electrical check before cutting and verifying that supply breakers are locked out and tagged out. Supervisors should ensure that the work instructions clearly identify the correct components to be worked on or removed. Marked-up drawings and marked, labeled, or tagged components can be helpful to ensure the correct components are being worked on. Managers and supervisors should review the following documents.

- U.S. Department of Labor, Occupational Safety and Health Administration standard “Selection and Use of Work Practices,” 29 CFR 1910.333, provides detailed guidance on electrical safety techniques during maintenance and construction.

- DOE/ID-10600, *Electrical Safety Guidelines*, section 2.13.2, states: “A qualified worker shall use test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are de-energized.” Personnel should check with a qualified electrician before cutting or disconnecting wires if it is not obvious to the eye that the wires are de-energized.

- DOE/EH-0557, Safety Notice 98-01, *Electrical Safety*, contains summaries, corrective actions, and recommendations related to electrical events. It notes that more than 800 occurrences involving electrical safety have been reported in the ORPS database between January 1990 and June 1998. Type A accident investigations have been conducted for five electrical accidents, three of which were fatal. Safety Notices are available at http://tis.eh.doe.gov/web/oeaf/lessons_learned/ons/ ons.html.

KEYWORDS: cable, conduit, electrical hazard, energized equipment, near miss

FUNCTIONAL AREAS: Construction, Electrical Maintenance, Industrial Safety

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. FISSILE MATERIAL HANDLERS FAIL TO WEAR EXTREMITY DOSIMETRY

On July 31, 1998, at the Los Alamos National Laboratory (LANL) Plutonium Processing and Handling Facility, fissile material handlers failed to wear extremity monitoring dosimetry (finger rings) while handling nuclear material containers containing significant quantities of plutonium. The handlers' failure to wear finger-ring dosimeters is a violation of the safe operating procedure for controlling radioactive contamination and radiation exposure and has been an ongoing issue since at least April 29, 1998. The facility manager held a safety meeting with Nuclear Materials Control and Accountability personnel and fissile material handlers, stressing requirements for wearing finger rings. The failure to wear the extremity monitoring devices resulted in under-reporting personnel extremity exposures that could have resulted in exposures above the DOE 5-rem threshold for required extremity dosimetry. (ORPS Report ALO-LA-LANL-TA55-1998-0036; Weekly Summary 98-31)

DOE Los Alamos Area Office personnel and facility representatives had observed several fissile material handlers not wearing extremity dosimeters while they handled containers of nuclear material from April 29 to May 7. When questioned, the handlers complained of cut gloves and fingers caused by the finger rings. Apparently, lifting heavy items contributed to the cuts while wearing the finger rings. A Health Physics Measurements representative stated that a new, wrist-type extremity dosimeter was in the making, but would not be ready for use until September 1998. On July 30, a Health Physics Operations team leader discovered that one of the individuals observed by the facility representative had not recorded extremity dose for several months. An employee who issues extremity dosimetry at the facility told the team leader that this individual had just returned seven extremity dosimeters and stated that there was no need to read them because they had not been worn. On August 3, 1998, the Nuclear Materials Control and Accountability acting deputy group leader held a safety meeting and instructed his material handlers that the wearing of extremity dosimetry devices was a requirement for their jobs just as the wearing of other protective clothing/equipment. All of the handlers signed an acknowledgement of the requirements.

The problems associated with personnel extremity monitoring at LANL had been previously identified during an assessment of the radiation protection program by the DOE Environment and Health (EH) representatives in April 1998. The assessment identified some problems in extremity monitoring that were subsequently discussed in a similar occurrence report (ALO-LA-LANL-TA55-1998-0016). Since April 29, 1998, LANL has implemented corrective actions that provide for better tracking and review of extremity doses. The LANL Radiation Protection Program manager appointed a working group for extremity monitoring to review all issues related to extremity monitoring.

The facility manager conducted an investigation of the extremity dosimetry problem. Investigators determined the direct cause was personnel error in that personnel failed to wear finger-ring dosimeters as required by procedure. The procedure states that a finger-ring dosimeter is required for glovebox work or work with significant quantities of radioactive materials outside of gloveboxes. Handlers that were observed not wearing their issued finger-ring dosimeters were trained on the procedure at the time.

Investigators determined that a contributing cause was a design problem in that the finger-ring dosimeters were uncomfortable to wear. The finger rings were made of a hard, brittle plastic that was rectangular in shape with square edges. Numerous finger-ring dosimeters were lost when personnel removed their protective gloves because the ring would come off inside the glove. They did not always realize the ring was missing because it was lightweight. To prevent the finger ring from coming off, personnel adjusted the band tightly around their finger, causing the sharp edges of the ring to cut into their fingers. This created an extremely uncomfortable situation, especially for personnel handling heavy containers of material. Additionally, the hard, brittle plastic band would often break when the ring was adjusted tightly. This also caused the loss of finger-ring dosimeters.

Investigators determined that another contributing cause was a deficiency in training. Personnel stated that they did not wear the finger-ring dosimeters because they did not realize it was a procedural requirement. None of the employees interviewed knew what procedure required them to wear finger-ring dosimeters. The safe operating procedure requires the use of finger-ring dosimeters for glovebox work or for handling significant quantities of radioactive materials. However, training and qualification on the procedure were accomplished through required reading and signing that one has read and understood the procedure. When the same personnel were asked what constituted a significant quantity of radioactive material, they could not provide the correct answer nor state where to find the answer, even though it is defined in the safe operating procedure for facility Nuclear Criticality Safety. Training and qualification on this procedure are also accomplished only by required reading. Investigators concluded that annual required reading of procedures alone was inadequate to ensure that personnel knew and understood the requirements of the procedures.

Investigators determined that the root cause was a management problem because personnel were unaware that they were required to wear finger-ring dosimeters (one individual had not worn a finger ring for at least 7 months). Also, investigators determined that the problem of not wearing the finger rings was not limited to personnel in Nuclear Materials Control and Accountability, but in other organizations, as well. Therefore, managers either were not enforcing the procedural requirements for wearing finger-ring dosimeters or were not properly disseminating the procedural requirements to applicable personnel.

The facility manager implemented the following corrective actions.

- Health Physics Operations personnel implemented a pilot program to test wrist-type extremity dosimetry. After the test program was successfully completed, they put into use the new extremity monitoring devices.

- Health Physics Operations personnel will revise the safe operating procedure.

- Performance, Assurance, Safety and Training personnel will develop a new training program following the revision of the safe operating procedure and will train personnel on the requirements of the revised procedure.

- Nuclear Materials Control and Accountability managers included dosimetry monitoring as part of their management walk-around. Since this occurrence, they have not observed the absence of monitoring devices. The new wrist-type extremity dosimeters are highly visible because they are brightly colored.

Since August 3, 1998, managers have observed (during routine management walk arounds), that their personnel have been wearing the proper personnel monitoring devices. Health Physics Operations personnel completed an extremity dose reconstruction for the employee that did not wear her extremity dosimetry for 7 months. The dose reconstruction estimated that the employee had received an extremity dose for gamma radiation of 0.939 rem and for neutron radiation of 0.939 rem. The total extremity dose for the employee was estimated at 1.878 rem.

This event underscores the importance of following the requirements addressed in safe operating procedures or radiological control procedures regarding the use of dosimetry. In this event, several employees failed to wear their extremity dosimeters while handling significant quantities of nuclear materials, which was in violation of procedures. Procedures are written to protect personnel, equipment, the facility, and to ensure a desired outcome; however, compliance with procedures is critical in order for them to be effective. While compliance with procedures is everyone's responsibility, line managers are responsible for ensuring that their personnel are in compliance.

KEYWORDS: dosimetry, extremity exposure, procedures, radiation protection

FUNCTIONAL AREAS: Procedures, Radiation Protection

OEAF FOLLOWUP ACTIVITIES

1. OPERATING EXPERIENCE WEEKLY SUMMARY NOW AVAILABLE VIA E-MAIL

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2. CORRECTION TO WEEKLY SUMMARY 99-34, FINAL REPORT ARTICLE 1

In Weekly Summary 99-34, the article titled “Subcontractor Employee Received Electrical Shock” incorrectly stated at the end of the second paragraph that “the helper inadvertently made contact with the energized 480-V bus bars.” The article should have stated that it was the laborer who inadvertently contacted the energized 480-V bus bars. (ORPS Report HQ-SPR-BH-1999-0004)